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(54) Abstract Title
Displaying images with gradations on a matrix-type display device

(57) The present method of displaying images with gradations on a matrix-type display device, includes the steps of (a) dividing the time period for selecting one or more scanning line at once into a plurality of time periods, the time widths of which are different from one another; (b) selecting one or more scanning lines through the driving means; (c) feeding gradation data for the pixels on the selected scanning line via the respective data lines; (d) combining the divided time periods based on the gradation data; (e) making the pixels on the selected scanning line emit light for the combined time periods based on the gradation data; and (f) repeating the steps (b) through (e) until all the scanning lines are selected once to display images with predetermined gradations.

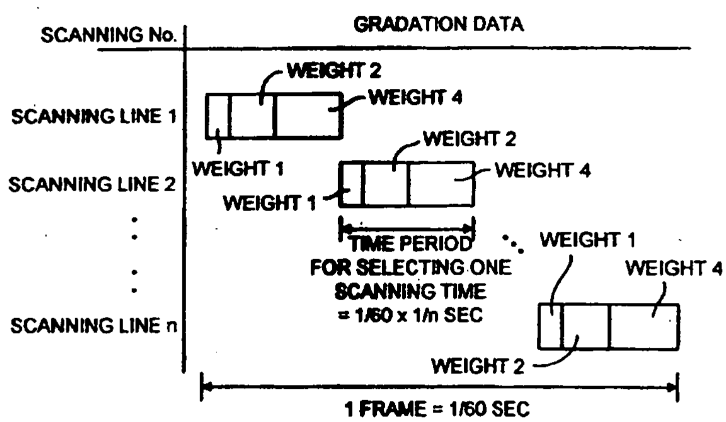

FIG. 3

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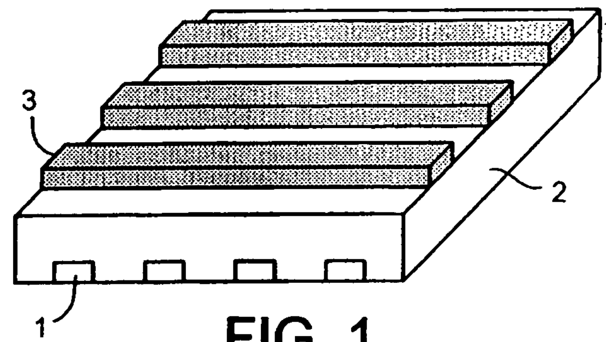

FIG. 1

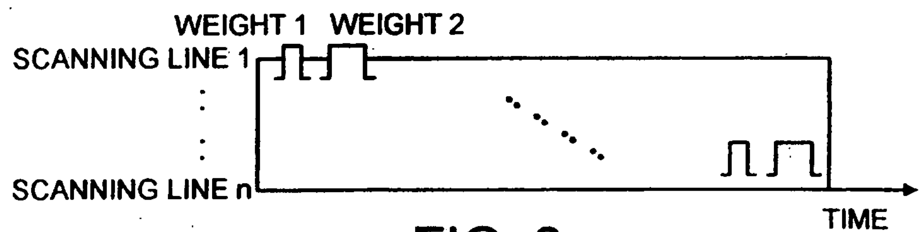

FIG. 2

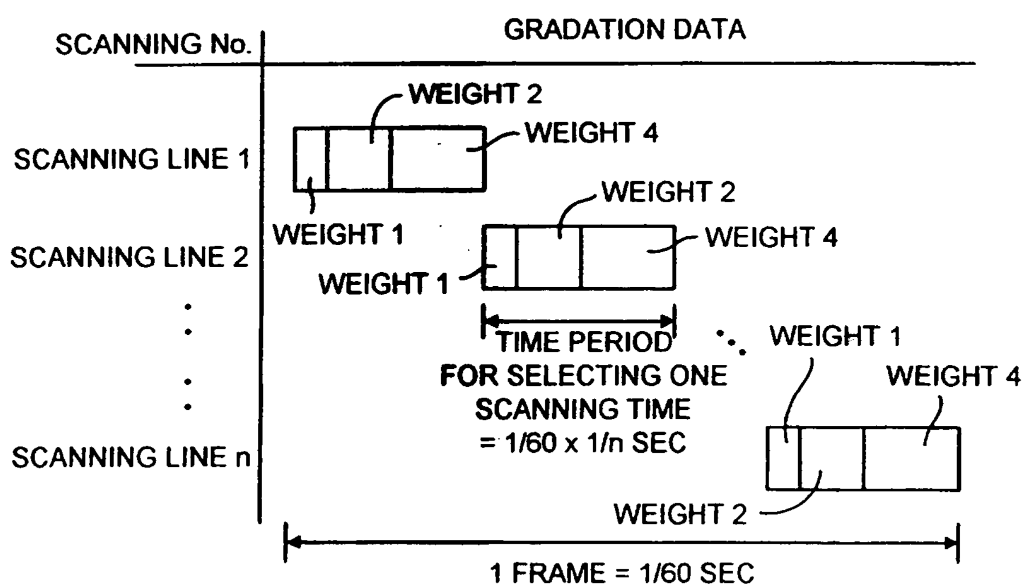

FIG. 3

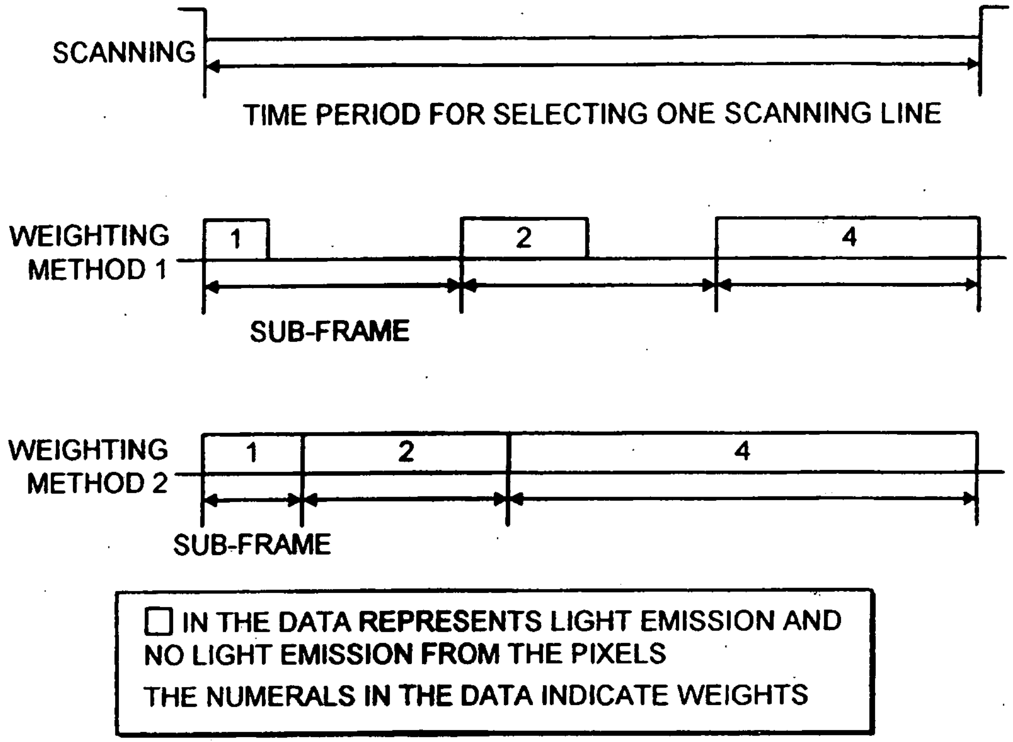
SCANNING
TIME PERIOD FOR SELECTING ONE SCANNING LINE
WEIGHTING METHOD 1
1
2
4
SUB-FRAME
WEIGHTING METHOD 2
1
2
4
SUB-FRAME
☐ IN THE DATA REPRESENTS LIGHT EMISSION AND NO LIGHT EMISSION FROM THE PIXELS
THE NUMERALS IN THE DATA INDICATE WEIGHTS

FIG. 4

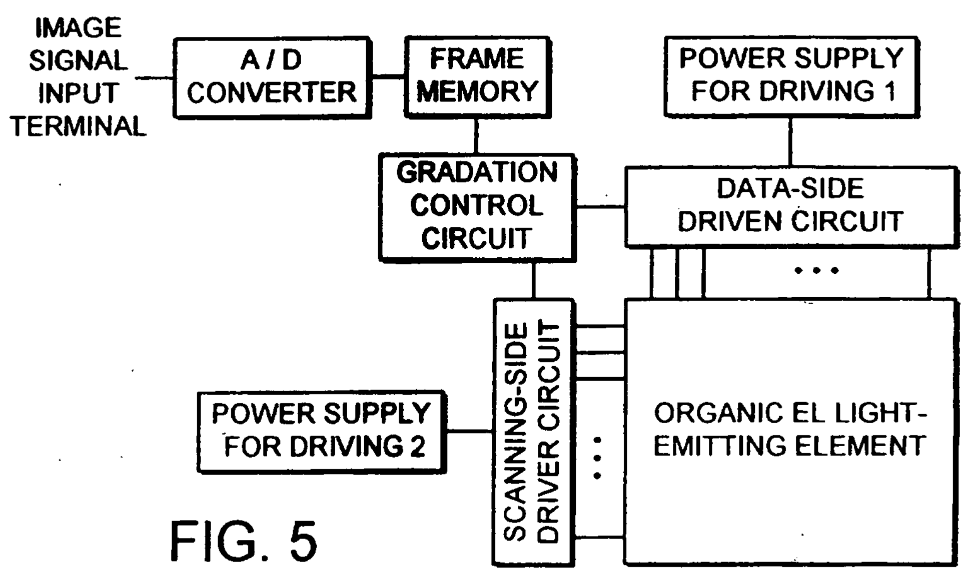
IMAGE SIGNAL INPUT TERMINAL
A / D CONVERTER
FRAME MEMORY
POWER SUPPLY FOR DRIVING 1
GRADATION CONTROL CIRCUIT
DATA-SIDE DRIVEN CIRCUIT
SCANNING-SIDE DRIVER CIRCUIT
POWER SUPPLY FOR DRIVING 2
ORGANIC EL LIGHT-EMITTING ELEMENT

FIG. 5

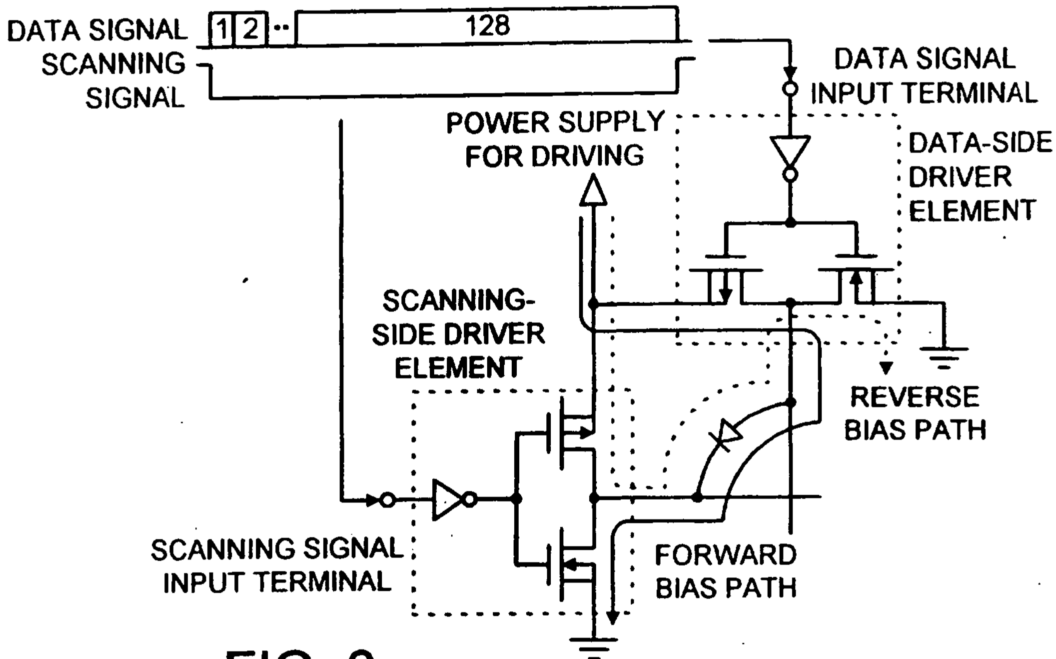
DATA SIGNAL
1
2
128
SCANNING SIGNAL
DATA SIGNAL INPUT TERMINAL
POWER SUPPLY FOR DRIVING
DATA-SIDE DRIVER ELEMENT
SCANNING-SIDE DRIVER ELEMENT
REVERSE BIAS PATH
SCANNING SIGNAL INPUT TERMINAL
FORWARD BIAS PATH

FIG. 6

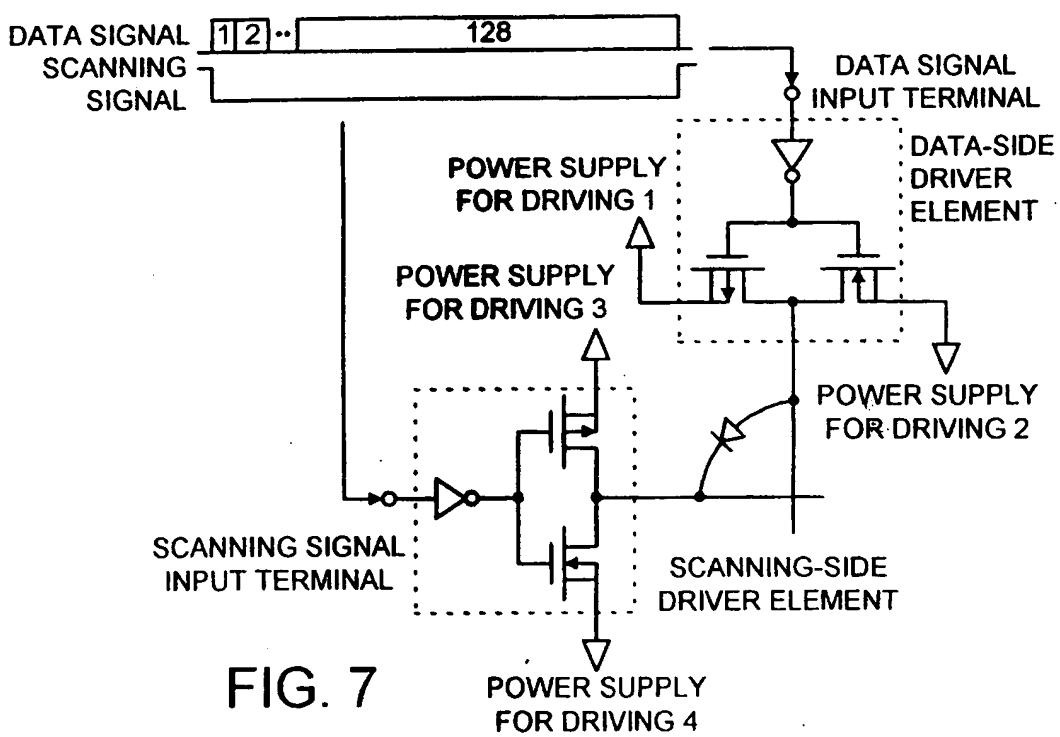
DATA SIGNAL
1
2
128
SCANNING SIGNAL
DATA SIGNAL INPUT TERMINAL
DATA-SIDE DRIVER ELEMENT
POWER SUPPLY FOR DRIVING 1
POWER SUPPLY FOR DRIVING 3
POWER SUPPLY FOR DRIVING 2
SCANNING SIGNAL INPUT TERMINAL
SCANNING-SIDE DRIVER ELEMENT
POWER SUPPLY FOR DRIVING 4

FIG. 7

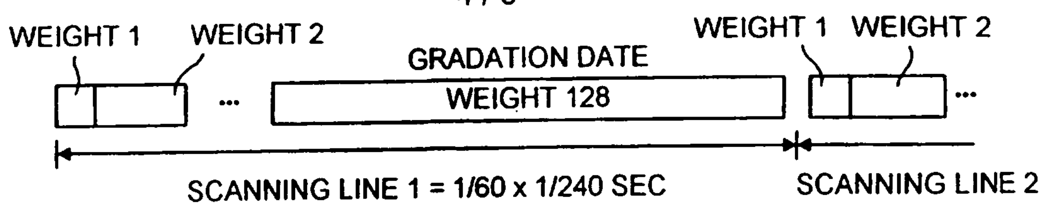

FIG. 8

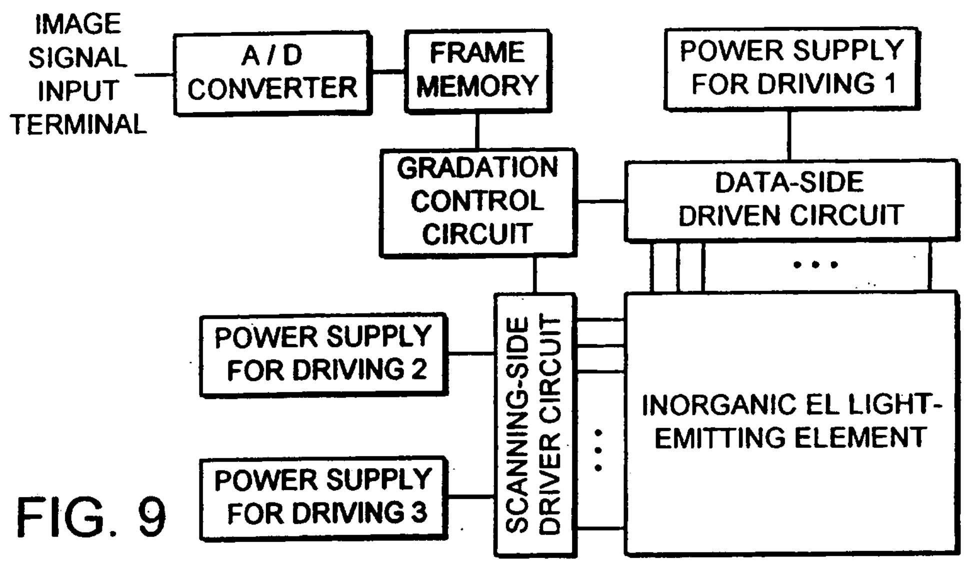

FIG. 9

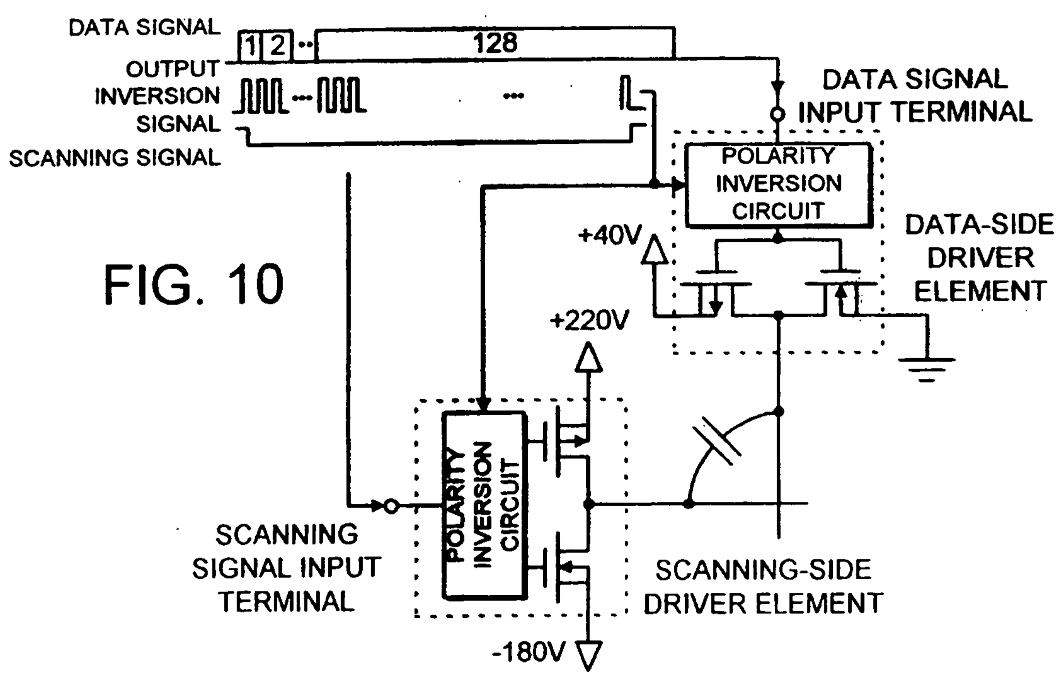

FIG. 10

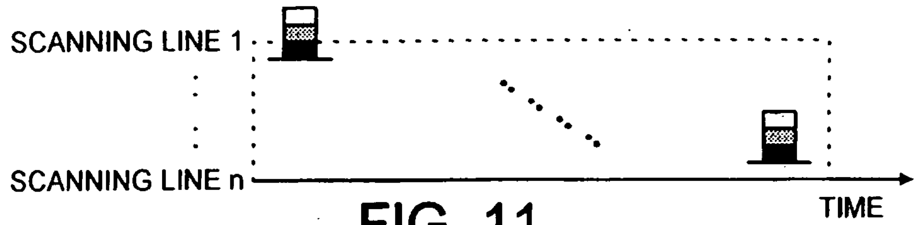

FIG. 11

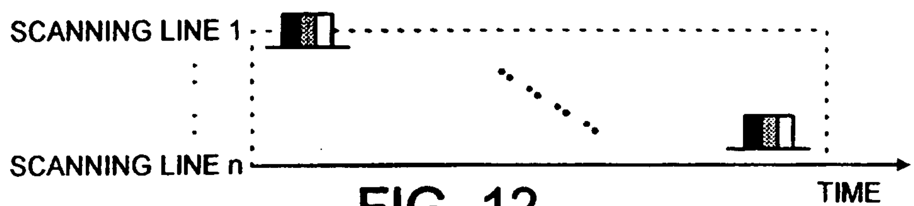

FIG. 12

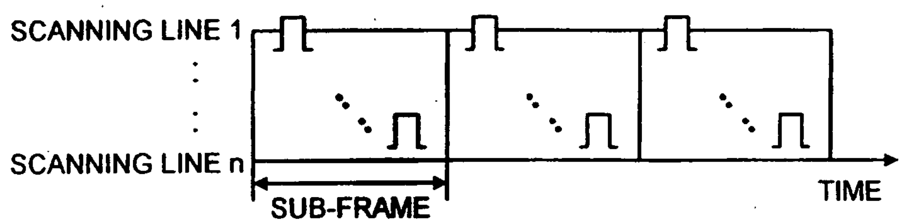

FIG. 13

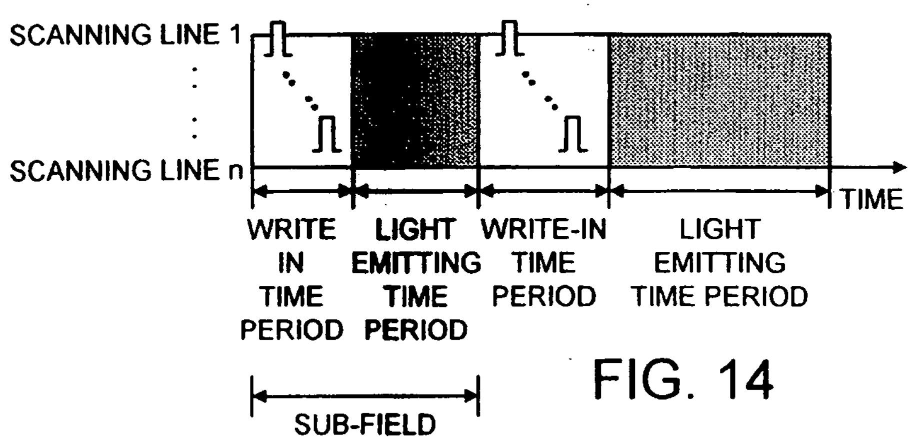

FIG. 14

METHOD OF DISPLAYING IMAGES WITH GRADATIONS ON MATRIX-TYPE DISPLAY DEVICE AND DISPLAY DEVICE USING THE SAME

The present invention relates to a method of displaying images with gradations on a matrix-type display device such as an organic electroluminescent light-emitting device (hereinafter referred to as the "organic EL device") and an inorganic electroluminescent light-emitting device (hereinafter referred to as the "inorganic EL device"). The matrix-type display device includes an organic or inorganic electroluminescent element and electrodes formed on the major surfaces of the light-emitting element such that pixels are formed in the portions of the light-emitting element sandwiched by the electrodes. The matrix-type display device makes the pixels emit light by applying a voltage between the electrodes. The present invention relates also to a matrix-type display device that employs the present method of displaying images with gradations. Specifically, the present invention relates also to a method and a device which facilitate stable and practical display of images with gradations.

The matrix-type display device includes light-emitting element, a first set of electrodes (hereinafter referred to as "first electrodes") on one major surface of the light-emitting element and a second set of electrodes (hereinafter referred to as "second electrodes") on another major surface of the light-emitting element. The first and second electrodes cross each other such that a matrix of pixels is formed in the portions of the light-emitting element sandwiched by the first and second electrodes. The matrix-type display device makes the pixels emit light by applying a voltage between the electrodes. The matrix-type display device displays images mainly by line-by-line scanning. For example, the first electrodes are defined as data lines, and the second electrodes as scanning lines. The matrix-type display device selects and scans one or more scanning lines and displays images based on the signals fed through the data lines to compose a scene. Fig. 1 shows an electrode structure of the matrix-type display device for displaying images with gradations. The display device in Fig. 1 includes a light-emitting layer 2, data lines

1 on one surface of the light-emitting layer 2, and scanning lines 3 on another surface of the light-emitting layer 2 and extending perpendicularly to the data lines 1. That is, the display device in Fig. 1 has an XY matrix electrode structure. The display device of Fig. 1 can display a scene by providing the display device with m+n pieces of driver elements, where m is the number of the data lines and n the number of the scanning lines. In contrast, the static diving requires m x n pieces of driver elements, each for directly driving each pixel.

In the line-by-line scanning, all the pixels do not emit light simultaneously. However, due to the integration effects of the human eyes, the light flashing on and off too fast to distinguish visually is detected as an average. Therefore, when the cycle frequency of the line-by-line scanning, i.e. the driving frequency, is too high to distinguish visually, flicker of the scene is not recognizable and a high image quality is obtained.

For displaying images with gradations on a display device that has a matrix-type electrode structure, it is necessary to conduct luminance control based on the gradation data contained in the inputted image signal. Luminance is controlled by changing the applied voltage value or the current value, or by changing the time period, in which a certain voltage or a certain current is fed. Luminance may be changed also by an appropriate combination of the foregoing methods. The method for gradation control used in these days employs voltage modulation, pulse width modulation, frame sampling or sub-field displaying.

The voltage modulation method changes the voltage applied in selecting and scanning the pixels corresponding to the respective gradations. The pulse width modulation method changes the pulse width while fixing the applied voltage at a certain value to control the gradation. The frame sampling method divides a frame into a plurality of sub-frames and controls the gradation by displaying some of the sub-frames and not displaying the rest of the sub-frames. The sub-field displaying method divides a frame into a plurality of

sub-fields, the time periods of which are different from one another such that the time width ratio of the sub-fields is the power of 2. And, the sub-field displaying method controls the gradations by appropriately combining the sub-fields.

The conventional methods for gradation control pose various technical problems to their image signal processing circuits and driver elements.

Fig. 11 is a timing chart explaining the scanning timing for displaying images with gradations by the voltage modulation method. The voltage modulation method is used mainly for liquid crystal displays. The voltage modulation method changes the voltage applied for selecting and scanning the pixels corresponding to their gradations. The voltage modulation method controls the gradations only by converting the gradation data to voltages without employing any additional special circuits and devices. However, it is necessary for the voltage modulation method to use voltage sources as many as the number of gradation levels. Especially when the luminance rises sharply with an increasing applied voltage, the voltage difference between the adjacent gradation levels is so small that it is required to use very precise voltage sources.

Fig. 12 is a timing chart explaining the scanning timing for displaying images with gradations by the pulse width modulation method. The pulse width modulation method fixes the applied voltage at a certain value and changes the pulse width corresponding to the gradations. The merit of the pulse width modulation method is that the visually observed luminance is proportional to the pulse width. However, when the gradation levels for the pixels scanned in a scanning line selection period are different, it is necessary to apply a voltage or to feed a current with different pulse widths. Due to this, it is necessary to provide a memory for storing voltage-pulse width data or current-pulse width data for each pixel. Therefore, the costs of the driver elements soar, causing total cost increase of the display panel.

Fig. 13 is a timing chart explaining the scanning timing for displaying images with gradations by the frame sampling method. The frame sampling method divides the frame constituting a scene into a plurality of sub-frames corresponding to the gradation levels and changes the luminance visually by intermittently sampling the sub-frames so that the gradation may be caused. According to the frame sampling method, it is not necessary to dispose any special processing means for gradation control in the subsequent stage of the circuit for generating a gradation signal for the frame. However, since the scanning is repeated same times as may as the number of the gradation levels, that is since the driving frequency is raised to control the gradation, it is necessary for the driving frequency to be high enough to facilitate very fine gradation control. Due to this, the time period for selecting and scanning each sub-frame is shortened. As a result, it is required for the gradation processing circuit and the driver elements to process the data very quickly. Here, we define the cycle of repeatedly scanning the frame in a unit period of time as the frame frequency . When the frame frequency is reduced to avoid the foregoing problem, flashing on and off of the pixels is observed as flickering, resulting in a poor image quality. When the frame frequency is raised, switching loss in the driver elements of the capacitive display panel, that is the power consumption in the driver elements, increases.

Fig. 14 is a timing chart explaining the scanning timing for displaying images with gradations by the sub-field displaying method. The sub-field displaying method is used for the plasma displays. According to the sub-field displaying method, write in of the gradation signals and light emission are conducted independently. By setting the ratio of the light-emitting time periods at the power of 2, the driving frequency is suppressed at a low value. The above described pulse width modulation method and frame sampling method divide a frame into equal time periods and combine appropriate time periods for gradation control. In contrast, the sub-field displaying method divides a frame into unequal time periods, the time width ratio of which is the power of 2, and combine appropriate time periods for gradation control. Since the time between the end of displaying one

scene and the start of displaying next scene is shorter than the time spent for constructing one scene according to the sub-field displaying method, the gradations of the adjacent scenes are observed as if they are mixing with each other. This phenomenon is caused due to the integration effect of the human eyes, which detect the light flashing on and off too fast to distinguish visually as an average. To describe in other words, since the time relations of feeding the gradation signals in a frame change greatly every time when the luminance to be displayed changes, images are observed brighter or darker than their gradation signals indicate. Since these phenomena appear on the screen as if outlines are drawn, they are called the false outline phenomena.

In view of the foregoing, it is an object of the invention to provide a stable and practical method and matrix-type display device for displaying images with gradations. It is another object of the invention to provide a method and a matrix-type display device for displaying images with gradations which facilitate processing the image signals at the similar speed as that by the pulse width modulation. It is still another object of the invention to provide a method and a matrix-type display device for displaying images with gradations which facilitate using the driver elements which have a circuit configuration as simple as the circuit configuration of the driver elements used for the frame sampling method. It is a further object of the invention to provide a method and a matrix-type display device for displaying images with gradations which facilitate suppressing the divisions of a frame at the similar number as that by the sub-field displaying method.

According to an aspect of the invention, there is provided a method of displaying images with gradations on a matrix-type display device, the matrix-type display device including a light-emitting element, a first set of electrodes, a second set of electrodes and a driving means, either one or both of the first set of electrodes and the second set of electrodes being transparent, the first set of electrodes and the second set of electrodes sandwiching the light-emitting element, the first set of electrodes and the second set of electrodes crossing each other such that a matrix of pixels are formed in the light-emitting element, the first set of electrodes

being defined as scanning lines, the second set of electrodes being defined as data lines, the method including the steps of: (a) dividing the time period for selecting one or more scanning lines at once into a plurality of time periods, the time widths of which are different from one another; (b) selecting one or more scanning lines via the driving means; (c) feeding a digital image signal including gradation data for the pixels on the selected one or more scanning lines through the respective data lines; (d) combining the divided time periods based on the gradation data; (e) making the pixels on the selected one or more scanning lines emit light for the combined time periods base on the gradation data; and (f) repeating the steps (b) through (e) until all the scanning lines are selected once to display images with predetermined gradations.

Advantageously, the time period for selecting one or more scanning lines at once is divided into a plurality of time periods, the time widths of which are different from one another such that the ratio of the time widths is the power of 2 corresponding to the weight of each bit of the digital image signal.

According to another aspect of the invention, there is provided a display device that includes an image signal input terminal; an A/D converting means; a memory means; a signal converting means; a driving means; and a matrix-type display means including data lines and scanning lines crossing each other such that pixels are formed; the A/D converting means converting an image signal inputted to the input terminal to a digital signal; the memory means storing the digital signal; the signal converting means converting the digital signal read out from the memory means to data signals including gradation data and a scanning signal corresponding to the data signals, the signal converting means dividing the time period for selecting one or more scanning lines at once into a plurality of time periods, the time widths thereof are different from one another, the signal converting means combining the divided time periods based on the gradation data; the driving means selecting one or more scanning lines at once based on the scanning signal fed from the signal converting means; the signal converting means feeding the gradation data for the pixels on the

selected one or more scanning lines to the driving means; the driving means supplying a voltage or a current to the matrix-type display means for making the pixels on the selected one or more scanning lines emit light with predetermined luminance for the combined time periods such that images are displayed with predetermined gradations.

Now the present invention will be explained hereinafter with reference to the accompanied drawing figures.

Fig. 1 is an isometric view of the display device having a matrix-type electrode structure;

Fig. 2 is a timing chart explaining the scanning timing for displaying images with gradations by the method according to the invention;

Fig. 3 a timing chart explaining the scanning timing for displaying images with gradations by the method according to the invention that divides the scanning-line-selection time period for scanning one into a plurality of time periods, the time width of which are different from one another;

Fig. 4 is a timing chart explaining the timings of the scanning signal and the data signal;

Fig. 5 is a block circuit diagram of the driver circuit according to the first embodiment of the invention;

Fig. 6 is a drawing describing the wave forms of the scanning and data signals and the current path at light emission in the first embodiment of the invention;

Fig. 7 is a drawing describing the wave forms of the scanning and data signals and the other current path at light emission in the first embodiment of the invention;

Fig. 8 is a timing chart explaining the scanning timing for controlling gradations on a scanning line according to the first embodiment of the invention;

Fig. 9 is a block circuit diagram of the driver circuit according to the second embodiment of the invention;

Fig. 10 is a drawing describing the wave forms of the scanning and data signals and the current path at light emission in the second embodiment of the invention;

Fig. 11 is a timing chart explaining the scanning timing for displaying images with gradations by the voltage modulation method;

Fig. 12 is a timing chart explaining the scanning timing for displaying images with gradations by the pulse width modulation method.

Fig. 13 is a timing chart explaining the scanning timing for displaying images with gradations by the frame sampling method; and,

Fig. 14 is a timing chart explaining the scanning timing for displaying images with gradations by the sub-field displaying method.

Fig. 2 is a timing chart explaining the scanning timing for displaying images with gradations by the method according to the invention. Fig. 3 a timing chart explaining the scanning timing for displaying images with gradations by the method according to the invention that divides the time period for scanning one scanning line of Fig. 2 into a plurality of time periods, the time width of which are different from one another. Referring now to these figures, after the weighting for one selected scanning line is finished, weighting is shifted to the next scanning line. A frame is completed by scanning all the scanning lines.

By weighting and dividing the gradation data of each pixel in one scanning-line-selection time period for selecting one or more scanning lines at once and by combining the weighted and divided gradation data to represent gradation, it becomes possible to display images with gradations without causing any alternation for the driver elements, any frame frequency rise and any flickering. Since the time period for constructing the gradation data for each pixel is much shorter than the time period of one frame, any false outline phenomenon is not caused.

The present invention is applicable easily to the display device including organic EL elements and such elements, the response speeds of which are much faster than the frequency obtained by multiplying the frame frequency, the time span between the scanning of one scanning line and next scanning of the same scanning line and the nth power of 2, where n is the number of divisions into which one scanning-line-selection time period for selecting one or more scanning lines at once is divided.

Various ways of arranging the weighted gradation data on a time scale may be applicable to displaying images with gradations according to the invention. Fig. 4 is a timing chart explaining the timings of the scanning signal and the data signal. Here, the unit of time period corresponding to the weight of each bit of the image signal, converted to the digital data in an A/D converting means, is defined as the sub-frame . In the method 1 for weighting the gradation, a frame of image data is divided into a plurality of sub-frames with an equal time period and the weight is changed from sub-frame to sub-frame. The method 1 is effective to suppress the transmission of the gradation signals at a low rate. It is not always necessary to provide all the sub-frame with an equal time period. In the method 2 for weighting the gradation, a frame of image data is divided into a plurality of sub-frames, the time periods of which are different from sub-frame to sub-frame corresponding to their weights. The method 2 is effective to realize high luminance, since the light-emitting time period may be maximized. The methods 1 or 2 is selected by changing the transmission timing of the gradation control signal and the operation timing of the driver elements. The basic principle is same for the methods 1 or 2.

According to these methods, stable and practical gradation control is facilitated by feeding the image data at a low transmission rate from an image signal processing circuit simply configured to data lines by driver elements with a simple circuit configuration.

The display device according to the invention includes an A/D converting means, a frame memory means, a signal converting means, a driving means and a display panel. The image signals inputted to the image input terminal of the display panel is converted to digital signals by A/D converters in the A/D converting means. The digital signals are stored in the frame memory means. The image signals read out from the frame memory means is converted to data signals employing the gradation control method of the invention and corresponding scanning signals in a gradation control circuit, i.e. a signal converting means. The driving means includes a scanning-side driver circuit, a data-side driver circuit and power supplies for the driver circuits. The driving means feeds a voltage or a current for emitting light with predetermined luminance based on the data signals and the scanning signals outputted from the signal converting means to drive the display panel so that images may be displayed with predetermined gradations. As shown in Fig. 1, the display panel includes an organic or inorganic EL element sandwiched by a first set of electrodes and a second set of electrodes crossing each other such that a matrix of pixels are formed in the EL element. Either one or both of the first set of electrodes and the second set of electrodes are optically transparent.

An explanation of the present invention follows, illustrated with preferred embodiments.

First embodiment

A color organic EL element includes 320 x 240 pixels between data lines, each including a transparent electrode, and scanning lines, each including a metal electrode. Each pixel is divided into three stripes extending in parallel to the data lines and corresponding to the three primary colors: red, green and blue. The color organic EL element

exhibits monopolar conductivity such that the conduction direction is from the transparent electrode to the metal electrode, i.e. from the data line to the scanning line.

The input image signal is an analog signal indicating red, green and blue with 256 gradation levels, weighted by the power of 2. One scanning-line-selection time period for selecting one or more scanning lines at once includes 8 pulses, the width ratio of which is 1: 2: 4: 8: 16: 32: 64: 128. Two hundred and fifty six periods of time are obtained for voltage application by combining display or not-display of these 8 pulses to control gradations. When the driving frequency is set at 60 Hz, the gradation frequency is 115 and the period is about 9 μs. Since the response speed of the organic EL element is sufficiently fast 1 μs or faster, images can be displayed with excellent gradations.

Fig. 5 is a block circuit diagram of the driver circuit for driving the organic EL element of the first embodiment of the invention. Referring now to Fig. 5, the image signal inputted to the A/D converter is converted to a digital signal of serial 8 bits. The digital signal is stored in the frame memory. The gradation control circuit reads out a bit corresponding to the weight of the gradation from the 8 bits and feeds the read out bit to the data-side driver circuit. The data-side driver circuit feeds voltages, each corresponding to light-emission or no light-emission, to the respective data lines. These operations are repeated for all the 8 bits in one scanning-line-selection time period to complete the gradation control for the selected one or more scanning lines.

The scanning-side driver circuit changes over its output voltage from a high potential to a low potential simultaneously with the start of every scanning. As a result of this operation, the potential across the pixel corresponding to the gradation signal indicating light-emission is lower on the side of the scanning line than on the side of the data line, that is a forward bias voltage is applied across the pixel. In contrast, the potential on the side of the data line of the pixel corresponding to the gradation signal

indicating no light-emission is not high enough with respect to the potential on the side of the scanning line to cause light emission. Fig. 6 is a drawing describing the wave forms of the scanning and data signals and the current path for light emission at a pixel in the display panel of Fig. 5.

As far as sufficient contrast is obtained between the light-emission and the non light-emission as described above, power supplies, the potentials of which are different may be used as shown in Fig. 7.

In the first embodiment, one scanning-line-selection time period for selecting one or more scanning lines at once is 1/60 x 1/240 sec. as shown in Fig. 8, since the frame frequency is 60 Hz and the number of the scanning lines is 240. This scanning-line-selection time period is much shorter than the time span between the end of scanning a scanning line and the start of next scanning of the same scanning line, that is 1/60 x 239/240 sec. Therefore, such false outline phenomena as those caused in the conventional sub-field method are avoided.

The configuration as described above is applicable also to the LED display device only be changing the power supply voltages, the output current value and the voltage value for initiating light emission.

Second embodiment

The method of displaying images with gradations according to the first embodiment is applicable also to the inorganic EL light-emitting device. A color inorganic EL element having a double insulation layer structure includes 640 x 480 pixels between data lines, each including a transparent electrode, and scanning lines, each including a metal electrode. Each pixel is divided into three stripes extending in parallel to the data lines and corresponding to the three primary colors: red, green and blue. The inorganic EL element, including a light-emitting layer and two insulation layers sandwiching the light-emitting layer, exhibits memory effects represented

equivalently by a capacitive load. Due to this, a pair of a positive pulse and a negative pulse is applied as a minimum light-emission unit. The pair of a positive pulse and a negative pulse facilitates making or not making the pixel emit light without taking the memory effects into account. Since the inorganic EL light-emitting device with a double insulation layer structure is driven by an AC current, there is no polarity in its driving. However, the transparent electrodes will be defined hereinafter as the "data lines" and the metal electrodes as the "scanning lines" for the sake of convenience.

Since the inorganic EL light-emitting device with a double insulation layer structure is a capacitive load, a current flows through the pixel and electric charges are stored in the capacitor represented equivalently. Once the electric charges are stored, that is charging up is finished, any current that contributes to light emission will not flow except a small leakage current. Light is emitted when recombination of the electrons flowing through the light-emitting layer and transition to low energy levels are caused. Therefore, the luminance of the inorganic EL light-emitting device with a double insulation layer structure is proportional to the number of pairs of a positive pulse and a negative pulse applied for a unit period of time in the time period for voltage application longer than the time period for completing charging up of the capacitance. For example, the method of gradation control according to the invention is applicable with no problems to the SrS: Ce light-emitting element with a double insulation layer, since its response speed is very fast 50 ns.

Fig. 9 is a block circuit diagram of the driver circuit for driving an inorganic EL device according to a second embodiment of the invention. Referring now to Fig. 9, an input image signal is processed in the same manner as in the first embodiment in the gradation control circuit and its preceding stages. In contrast to the organic EL element, the inorganic EL element with a double insulation layer structure is driven by applying bipolar pulses. When a pair of a positive pulse and a negative pulse is assigned to a minimum light emission unit, the logic of the output from the data-side driver circuit is inverted once in the sub-frame, the weight of which is 1.

In response to this, the logic of the output from the scanning-side driver circuit is also inverted once. In the same way, the logic of the output from the data-side driver circuit and the logic of the output from the scanning-side driver circuit are inverted certain times corresponding to the weight of each sub-frame. Thus, gradation control is facilitated in the same way as by the first embodiment.

Fig. 10 is a drawing describing the wave forms of the scanning and data signals and the current path for emitting light from a pixel in the inorganic El element of Fig.9. Fig. 10 shows the potential relations between the data line and the scanning line when the voltage for initiating light emission is 180 V. When the scanning pulse is +220 V, light is emitted by biasing the data line at 0 V, and light is not emitted by biasing the data line at +40 V. When the polarity of the scanning pulse is inverted to 180 V, light is emitted by biasing the data line at +40 V, and light is not emitted by biasing the data line at 0 V. Since a polarity inversion circuit incorporated in the driver element is used for the above described operations, the same circuits used in the first embodiment for gradation control are employable also in the second embodiment.

In the second embodiment, one scanning-line-selection time period for selecting one or more scanning lines at once is 1/60 x 1/480 sec., since the frame frequency is 60 Hz and the number of the scanning lines is 480. This scanning-line-selection time period for selecting one or more scanning lines at once is much shorter than the time span between the end of scanning a scanning line and the start of next scanning of the same scanning line, that is 1/60 x 479/480 sec. Therefore, such false outline phenomena as those caused in the conventional sub-field method are avoided.

Although the invention has been explained by way of the preferred embodiments thereof, various modifications will be obvious to those skilled in the art without departing from the gist of the invention. Therefore, the invention be understood not by the specific disclosure herein but only by the appended claims thereof.

As explained above, the present invention provides a stable and practical method for displaying images with gradations on a simple-matrix-type display device including a light-emitting element such as the organic EL element and the inorganic EL. The present method facilitates displaying images with gradations on a simple-matrix-type display device by feeding the image data at a low transmission speed from a simple image signal processing circuit using driver elements with a simple circuit configuration.

3. A display device comprising:

an image signal input terminal;
an A/D converting means;
a memory means;
a signal converting means;
a driving means; and
a matrix-type display means including data lines and scanning lines crossing each other such that pixels are formed;
the A/D converting means converting an image signal inputted to the input terminal to a digital signal;
the memory means storing the digital signal;
the signal converting means converting the digital signal read out from the memory means to data signals including gradation data and a scanning signal corresponding to the data signals, the signal converting means dividing the time period for selecting one or more scanning lines at once into a plurality of time periods, the time widths thereof are different from one another, the signal converting means combining the divided time periods based on the gradation data;
the driving means selecting one or more scanning lines at once based on the scanning signal fed from the signal converting means;
the signal converting means feeding the gradation data for the pixels on the selected one or more scanning lines to the driving means;
the driving means supplying a voltage or a current to the matrix-type display means for making the pixels on the selected one or more scanning lines emit light with predetermined luminance for the combined time periods, whereby to display images with predetermined gradations.

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Application No:	GB 9907814.9	**Examiner:**	Paul Jefferies
Claims searched:	1-3	**Date of search:**	29 June 1999

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G5C

Int Cl (Ed.6): G09G 3/30, 3/32

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0457440 A2	(THE CHERRY CORPORATION)	1-3
X	EP 0372364 A1	(SHARP K K) See column 9, lines 14-40	1-3
X	US 5652600	(PLANAR SYSTEMS INC.) See column 2, lines 54 et seq.	1-3

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
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